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13. ABSTRACT (Maximum 200 words)

The first of its kind prototype Internet-based distributed team simulation software offering full portability and based exclusively on the Java programming language has been completed. SynTEAM (Synthetic Team Evaluation and Modeling), an inexpensive research/training simulator, will allow commanders to remotely configure scenario "kits" from a library of kit exercises in an effort to study a variety of team-based command and control decision behaviors. While the current simulator is programmed as an AWACS weapon director's platform, it has been designed to provide rapid prototyping for other military applications. The simulator development program includes: audio/video streaming, intelligent agent applications, graphical measures of quantitative information, and telephony and other messaging vehicles to keep commanders abreast of real-time and off-line scenario events.

We are currently developing extensions to the SynTEAM Internet Simulator for the "SynTEAM Federated Internet 2 Architecture Project (SFIA)." The goal of SFIA development will be creating network technology that will make it possible to: 1) unite AFOSR simulation programs by creating a common set of protocol standards and tools that will allow integration of multiple simulators in support of Joint Battle space training directives, and 2) configure these standards to be directly compatible with the broad-band connectivity provided by ATM Internet 2 technology.

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August 30, 2000

From AHARP (Advanced Human Research Project)
Robert P. Mahan, PhD

Final Report AFOSR, ARL/HEAB

To: Dr. Sam Schiflett, ARL/HEAB

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OVERVIEW

SynTEAM Federated Internet Architecture (SFIA)

SFIA is an Internet architecture framework that will support federated multi-operator distributed simulation exercises, as well as corresponding application development. The focus of this effort is to create a federated internet application system that will integrate existing and future simulators in an effort to create a scaled joint battlespace research and training program. The immediate goals of the distributed internet architecture effort is to delineate the components, protocols, and program language infrastructure that will produce a system of platform independent tools that can serve all phases of distributed internet simulation, from exercise planning and development, to execution, evaluation, and feedback. SFIA will leverage the advanced internet-II strategic alliance program, which has been designed to facilitate access to current and future highly integrated, digital communications services for education and research. Internet-II connectivity will provide reliable communications system with the ability to integrate high performance voice, data and video services in a competitive multi-vendor environment at reasonable cost and with a quality of service standard.

Three components of the SFIA

1. Simulation Authoring System- (SAS)
2. Integrative Simulation Management Engine (ISME)
3. Performance Assessment and Debriefing System (PADS)

1. Simulation Authoring System- (SAS)

SAS will be a graphic user interface tool-set that will allow rapid scripting of multi-operator exercises.

SAS will be composed of two basic modules:

Object database that will provide the battlespace entities, as well as define their properties and features.

Scripting program that will support scenario planning and development, scenario visualization, and battlespace configuration.

2. Integrated Simulation Management Engine (ISME)

ISME will provide the utilities for real-time monitoring of scenario execution, messaging, data collection and archiving, as well as other technical components of SFIA.

ISME will rely on run-time infrastructure using High Level Corba Architecture, which will provide wide-band, high-speed federated control over scenario actions. The run-time module will control multi-cast team tasks, provide capabilities to query and analyze network nodes, and furnish alerts on networking malfunctions.

3. Performance Assessment and Debriefing System (PADS)

PADS will be composed of real-time modeling of scenario performance data. In addition, it will offer the tools for offline data analysis. PADS will leverage cutting edge data visualization techniques including integral display technology and immersive 3-D protocols.

Joint SynTEAM Battle Space Program

AHRP Laboratory Segment

University of Georgia

Task Platforms

UGA's facet of SynTEAM focuses on AWACS Weapons Directors with highly configurable fidelity options. In addition, other domains are easily added to the underlying simulation framework.

Individual or Team

Participants may work either individually or in teams.

How Networked

Networked communication uses the CORBA protocol and the Visibroker ORB in a client-server architecture. Connections to federated simulations may be implemented with adapters at the server.

Readiness for Internet / Internet2

Architecture relies on Internet connectivity; intranets may also be used if DNS service is available. Because UGA is an Internet2 partner, connections to other Internet2 institutions are automatically routed through Internet2 backbones. As new Internet2 features (e.g., IPv6, QoS, CoS), become available, SynTEAM's modular design will allow us to begin using them quickly.

Who Can Talk to Whom

All text communication between participants simulates face to face Communication between WD's. Although communication may be marked for a specific individual, everyone "hears" every message.

Voice communication currently uses embedded Microsoft NetMeeting technology, again simulating face to face communication. Another voice communication system using RTP and JMF is under construction. The new system will feature configurable bandwidth, noise levels, and data archive.

Communication from participants to simulated entities is performed With context-sensitive menus. Communication from entities to participants currently comes through text messages, while the next voice communication system will also allow prerecorded audio entity-to-participant messages.

Relevance to Training

SFIA offers an easily configurable research and training system that, in theory, can support rapid prototyping through its modular 3-tier architecture design. In the coming months, the platform will incorporate a number of experimental protocols and training/support functions (described below).

Performance Measures

A) Embedded Real-time Support

Individual

a. Signal Detection- simulation solicited events for discrete choice points to model an operator's capacity to detect a signal against background of noise. [Individual Outcome and some Process]

b. Judgment Analysis- epoch-based embedded application of social judgment theory focusing on multi-sensor values and operator criterion judgments.

c. Information integration- Algorithm configured to combine subjective judgments on operational parameters in a fashion analogous expected utility. [Individual Outcome and Process]

d. Recognition Primed (RPD)- Algorithm for collecting response data on perceived operational context, and the subsequent action policy executed (similar to judgment analysis). [Individual Process]

e. A fuzzyneuro utility/controller that is designed to detect fluctuations in decision making over a prescribed decision time-horizon on the basis of computed moving averages in a number of behavioral and cognitive indices such as, response rate, accuracy with external criteria, response consistency, agreement (team measure), cue profile matching indices, and error distribution values. [Individual Process with some Outcome]

Team

f. TIDE^2- Epoch-based assessment relying on hierarchical regression. [Team Outcome and Team Process]

g. Conflict/Constraint Theory- Focus on remediation in conflicting models of team goals. In part quantified via Judgment analysis protocols replacing criterion with team-member criterion judgments. [Team Process]

h. Communication Shared Sampling Methodology. This is a modeling technique under development that benchmarks Team Situational Awareness via modeling team-task communication content.

i. Computational simulation methodology for predicting Team SA and evaluating team member attrition/turnover on team functioning.

Capabilities

With the exception of the fuzzyneuro controller that is essentially passive, the above measures require event-driven response solicitations executed by software agents. Data is then parsed at the server and used for training feedback and/or for decision support alerts. Scenario replay is supported.

Research Issues

Individual and Team Behavior

Decision-making effectiveness depends on 1) task/mission properties (e.g., information quantity and complexity, uncertainty and ambiguity), as well as other ecological components (e.g., workload, time-of-day); 2) representational forms and interface

engineering protocols (e.g., animated, static, morphing displays), 3) and id variables (expertise, psychophysiological state, gender, age, etc.).

SynTEAM Technical Overview

SynTEAM's technical infrastructure was designed to meet three primary goals:

- **Efficiency**: SynTEAM should be able to run on minimal client machines. The latest Pentium III or G4 processors should not be required.
- **Power**: SynTEAM's design should facilitate easy incorporation of advanced performance analysis algorithms. Because many of these algorithms might require intense computation, SynTEAM's design should be easily portable to high-performance server hardware.
- **Flexibility**: SynTEAM should allow a wide range of possible scenario kits. Also, administrators must be able to configure simulations for day-to-day needs without designing completely new scenario kits. **And where possible, SynTEAM must allow for eventual extension into domains beyond AWACS weapons direction.**

The following sections will describe SynTEAM's technical features and show how the three design goals have been met.

Industry Standards

Java

- All major components of SFIA/SynTEAM are written in Java, a software development language that is an alternative to C/C++, Ada, or Pascal.
- Unlike other languages, Java is "write once, run anywhere," reducing long, costly rewrites when porting applications to other platforms.
- Therefore, while SFIA/SynTEAM was developed primarily for the Windows family of operating systems, it can be quickly and cheaply ported to Macintosh, UNIX, Linux, Solaris, and other systems.
- The major drawback of Java compared to other software development languages is performance. However, SFIA's design compensates for this problem by delegating most computationally intensive tasks to a high performance server and by offering customizable realism settings.

CORBA

- CORBA is a distributed object communications protocol similar in scope to DCOM, RMI, and HLA. It is the standard mechanism for client-server communications in SFIA, including the following:
  - Joining and starting simulations
  - Battlespace updates
  - Transmitting participants' commands
  - Text communication

- Standardized by the largest consortium in the history of the industry, CORBA is the leading distributed object communications protocol. This ensures support and improvements for many years to come.
- CORBA allows applications written in different languages with a minimum of development time and cost. Should the Java-based server application be replaced with a high-performance C-based application in the future, using CORBA ensures that client applications will still function without change.
- In SFIA/SynTEAM, the communications system is extremely modular. So if the arises to switch to a different protocol such as HLA, the transition will be relatively fast and inexpensive.

SynTEAM Federated Internet Architecture

Generalized SynTEAM Architecture

- Every major aspect of SynTEAM has been designed for future expandability. This includes simulation of other domains such as UAV, complete force structure, and business. Thus, all aspects of SynTEAM that apply to *all types* of continuous event simulations have been "factored out" into a separate set of modules called the SynTEAM Federated Internet Architecture (SFIA):

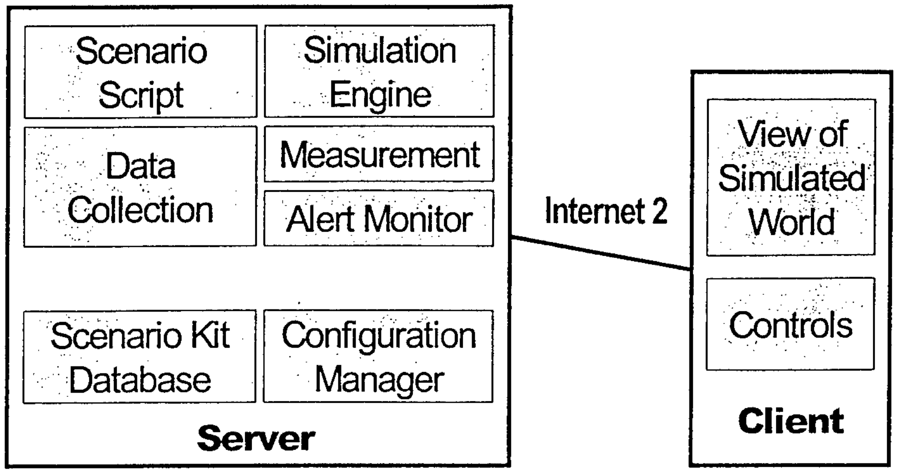


Figure 1: SFIA Structure

- Communication standards between participants, intelligent agents, and simulated entities (see CORBA above).
- Distributed simulation logic such as miniworld maintenance and distribution.
- Data collection and analysis procedures.

Server Duties

- As shown in Figure 1, most computationally intensive tasks are performed at the server. This means that client machines need to meet only minimum hardware requirements.
- The server maintains the battlespace and continually updates the state of simulated entities such as fighters, tankers, SAM sites, etc.
- The server also offers configural realism so administrators can select the proper balance between realism and performance.

Entity Specification

- The term *simulated entity* refers to an object that is simulated during the course of a SynTEAM scenario, such as a tanker, fighter plane or air base.
- Entities are organized in an **inheritance hierarchy**.
  - The use of an inheritance hierarchy allows developers to easily update the behavior of many simulated entities simultaneously.
  - For example, consider the sample inheritance hierarchy in Figure 2. If a developer wants to add a more realistic fuel consumption algorithm to all simulated airplanes, he or she has only to change the behavior of the *Aircraft* entity, and all entities below *Aircraft* in the hierarchy will inherit the new behavior.

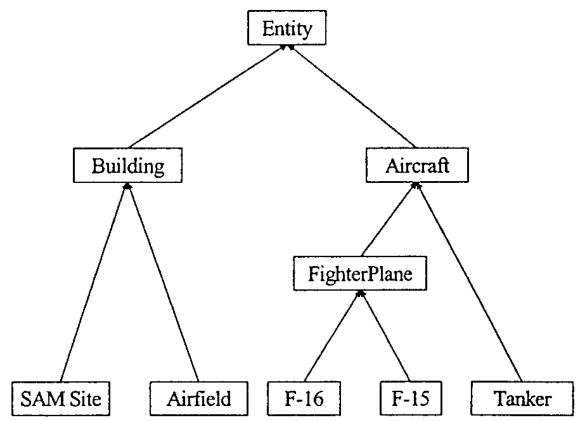


Figure 2. Example Inheritance Hierarchy

  - The alternative would be to update each individual plane. As SynTEAM matures, this might mean having to make changes to *hundreds* of individual planes, one at a time.
  - Thus, the use of an inheritance hierarchy translates into a lower "cost of ownership" of SynTEAM during the platform's lifetime.

- **Adapter entities** can serve as proxy connections to other simulation technologies such as HLA, ModSAF, and JSAF. Complete HLA/ModSAF compliance can be achieved by switching the communications layer from CORBA to HLA.

Data Collection

- Data logs in SFIA/SynTEAM can be saved in one of two formats: verbal or numeric. The numeric format is ideal for use with statistical analysis software packages, while the human-readable verbal format is useful for discovering complex patterns.
- A conversion application is provided to translate numeric logs into the verbal format.
- The server always saves a "legend" that defines all symbols used in the numeric log. This legend can be stored with the log so that future researchers and trainers can understand the logs even if the SFIA applications are not available.
- The numeric log format is designed to be easily imported into analysis packages such as Excel, SPSS, and SAS.
- What is saved:
    - Participants' commands to:
        - Simulated entities (target, orbit, RTB)
        - Other participants (text communication)
        - GUI display (zoom, declutter)
    - All command execution styles
        - Keyboard, menu bar, context menus, mouse

        - This unique feature is essential for research on interface designs and their impact on SA.
    - Automation
        - Scripted events
        - Entity-generated commands (shoot down, exit miniworld)
    - Triggered comments to record domain-specific events
- All data events are time-stamps to within 1ms or the highest resolution of the computer.
- If a simulation is interrupted by an error, an error log is generated that saves information to help developers identify and remove any bugs.

AWACS Miniworld

Entity Behavior

- Although SynTEAM is not designed to be an ultra-high fidelity simulator, every effort is being made to imbue the simulated entities with psychologically realistic behavior.
- Wherever possible, entity attributes such as maximum airspeed, optimum airspeed, fuel capacity, fuel consumption, and fuel transfer rate are based on declassified data on the actual vehicles. Sources include Mathieu Dalrymple at Brooks AFB and *United States Military Aircraft Since 1909* by Gordon Swanborough and Peter M. Bowers.
- Examples:
    - F-15

        - Maximum speed: 1600 nmph
        - Optimal speed: 620 nmph
        - Optimal altitude: 40000 f
        - Fuel capacity: 20916 lb
        - Fuel consumption rate: 224 lb/min
    - F-16
        - Maximum speed: 1600 nmph
        - Optimal speed: 580 nmph
        - Optimal altitude: 32000 f
        - Fuel capacity: 6972 lb
        - Fuel consumption rate: 112 lb/min
    - KC-135R Tanker
        - Maximum speed: 585 nmph
        - Optimal speed: 380 nmph
        - Optimal altitude: 27,000f
        - Fuel capacity: 120,000 lb
        - Flies in "cells" of 3 tankers awaiting other aircraft in need of refueling.
- However, if a scenario should require the simulation of an entity that does not conform to normal specifications, all entity attributes are easily configurable.

Terrain

- AWACS simulations have taken several different approaches to the representation and storage of terrain on the radar view. Two common approaches have been rejected for SynTEAM because of various faults:

- *Raster* approaches represent terrain in a bitmap format such as GIF or JPEG. But raster formats have large storage requirements, both on disk and in RAM. Furthermore, zooming with raster formats is computationally intensive, and terrain quickly becomes jagged and unrecognizable at higher zoom levels. Finally, raster-based terrain displays bear little resemblance to real AWACS displays.
- *Arc-based* approaches represent terrain as a system of intersecting circles that overlap to form irregular terrain shapes. While arc-based formats have much lower storage and processing requirements than raster formats, terrain creation is difficult and counter-intuitive. Also, arc-based based terrain looks markedly different from actual AWACS terrain display.

- **Vector-based** terrain, the approach used in SynTEAM as well as real AWACS displays, is represented as complex polygons. Like the arc-based approach, the vector-based approach has very low storage and processing requirements, but the vector-based format allows for much more complex and realistic terrain outlines. Vector-based terrain creation is quick and intuitive.

Client Facilities

- The **radar view** is SynTEAM's primary view into the battlespace. SynTEAM's radar view uses standard track icons and vector-based terrain display. The screen is mouse-aware, allowing the WD to select tracks with the left button and send

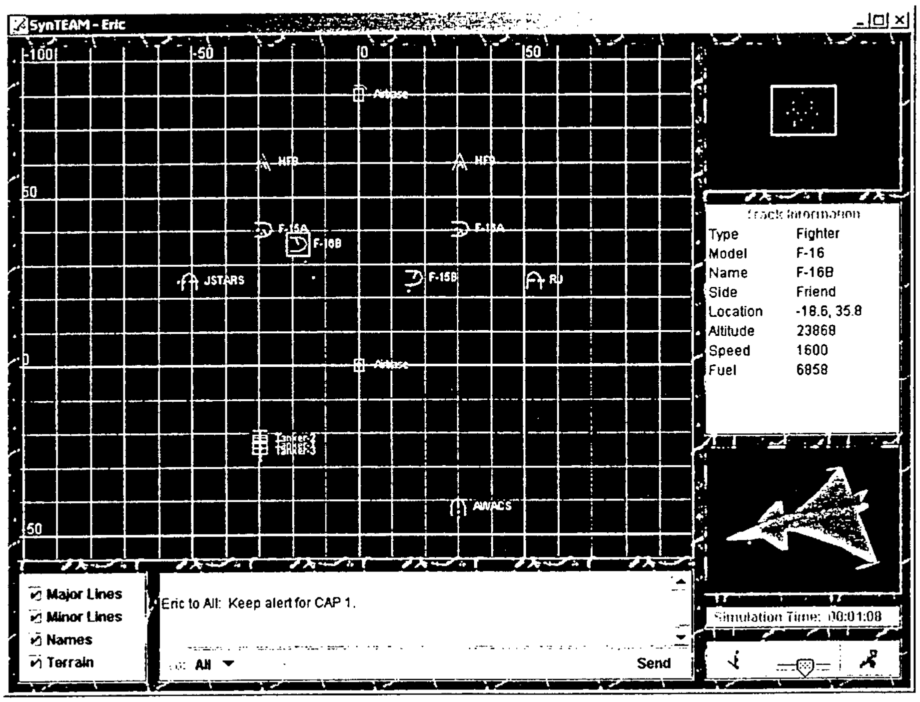


Figure 3: Client Screen

commands to entities with context-sensitive menus brought up with the right button.

- The **declutter controls** allow WD's to change the amount and type of information on the radar screen. Display of grid lines (both major and minor), terrain, and track names can be controlled here.

- The **overhead view** shows a fully zoomed-out view of the battlespace. It can be used to compensate for the typical PC monitor's smaller size compared to a real AWCAS radar screen.
- The **track information** window displays all known characteristics about the selected radar track. Categories are adjusted according to the track type and the data access of the WD.
- The **simulation time** cell shows the time within the simulation. The display is necessary because SynTEAM's time compression feature allows administrators to run scenarios faster or slower than real time.
- The **text communication** window presents participant-to-participant and entity-to-participant messages. Although this functionality will eventually be replaced by audio messages, the relative immaturity of voice-over-IP technology dictates that SynTEAM retain text information capability for the time being.

Administrator Facilities

Scenario Kit Generator

- Most low- to mid-fidelity AWACS simulators use encoded text files to store scenario kit information. The coding schemes used by these simulators are often so cryptic that only developers—not users—can create scenario kits. Coded text files are also extremely error-prone.
- SynTEAM's Scenario Kit Generator allows WYSIWYG creation of AWACS scenarios in the same visual paradigm used by trainers in the field today.

- **Initial Force Layout**: Using a drag-and-drop interface, administrators can visually lay down the initial force structure in the main window.

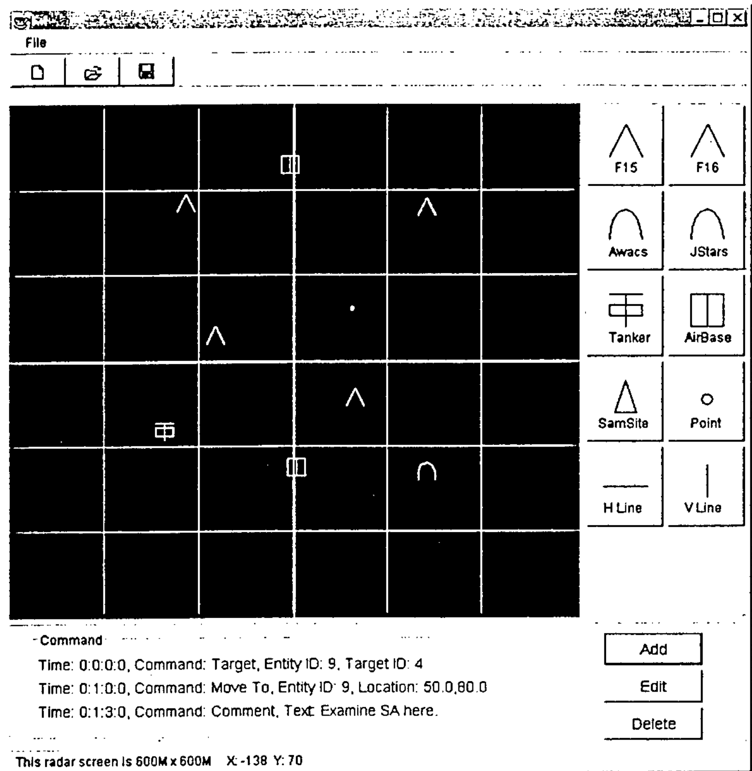


Figure 4: Scenario Kit Generator

- **Scenario Script**: Here, administrators can enter simulation events in easy-to-use forms. Unlike older systems that use text-based scripts, the Scenario Kit Generator checks scripts for errors *before* running a simulation, streamlining the kit development time.

Runtime Scenario Configuration

- **Scenario Kit Choice**: Administrators can choose one of the installed scenario kits from a drop-down list box.

- **Time Compression**: Often, the normal time-course of an AWACS simulation is too slow for a given research or training need, with long stretches of inactivity between decision points. The normal time-course can also be too slow, particularly for training, forcing an inexperienced trainee to cope with unfamiliar tactical problems that emerge too quickly. To deal with both of these situations, SynTEAM allows the administrator to set the ratio of simulation time to real time.

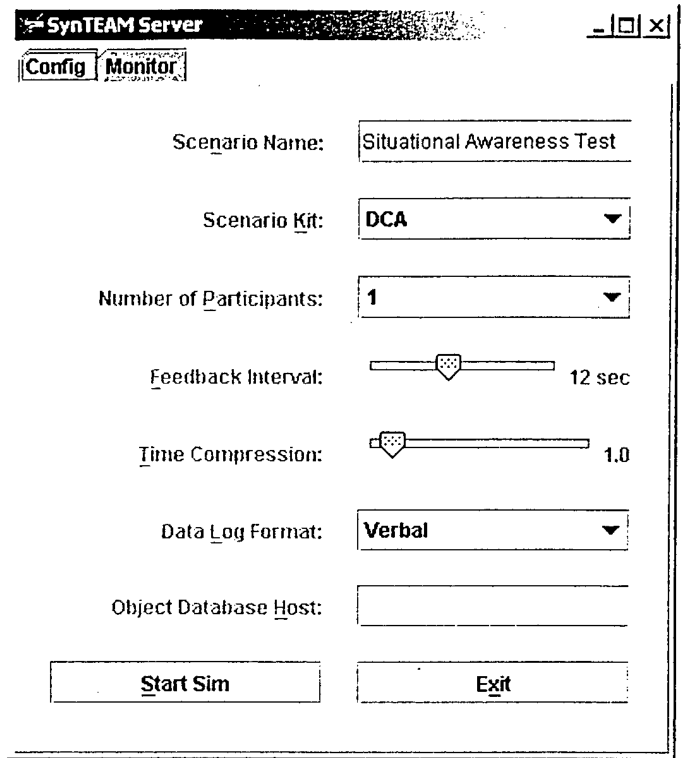


Figure 5: Administrator Configuration Screen

- **Feedback Interval**: Because delayed, intermittent feedback can have a very important impact on performance, administrators can use this option to set radar sweep intervals to times other than the default 12 seconds.

- **Participant Number**: Finally, administrators can set the number of human participants in the simulation.

Real Time Analysis

- **Zoom View SA Agent**: SFIA/SynTEAM's architecture was designed to allow quick, easy implementation of a number of performance, decision, and SA analysis algorithms. The Zoom View SA Agent is the first prototype, designed to

monitor the time each participant spends at high zoom levels. Because high zoom levels limit the total amount of battlespace information that is displayed, spending too long at a high zoom level can lead to reduced SA. Should a participant exceed a preset limit of continuous zoom-in time, the Agent will alert the administrator.

SFIA

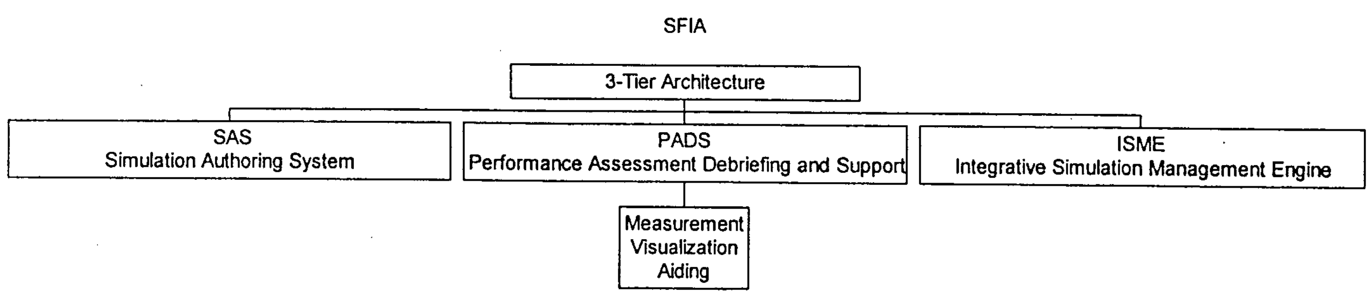
SynTEAM Federated Internet Architecture

Advanced Human Resource Project Lab

University of Georgia

Athens, Georgia

SFIA Overview



Goals:
3-Tier Architecture

- Beyond
  - Task/Domain/Service Specific Designs
  - Functional Paradigms
- Toward
  - Mixed-Domain/Joint Force Designs
  - Entity-Level Inheritance Paradigms

Why SFIA?

- Research
  - Distributed Multi-user Environments
  - Develop Training Systems
- Experimental Application
  - Modeling New Technology and Systems
  - Test-bed for New Doctrine/Tactical Constructs
  - Configurable Global Object Data-Base
    - Geopolitical Entities
    - Coalition
    - Weather
    - Time-of-Day
- Broad Band Internet Connectivity

SFIA Capabilities

- Discrete and Continuous Modeling of Scenarios
- Scalable Architecture
- 2 and 3 Dimensional Representation
  - New Emersive Protocols
- High Speed Network (e.g. Internet 2) Compliant
- Rapid Prototyping and Modeling
- Dynamically Interactive Kits

SFIA- Phase II

- Synthetic Enemy Doctrine and Forces
  - Real Aircraft/Command and Control
- Synthetic Environments and Effects
  - Scaled Object Data Bases
  - Real-Time Weather
- Advanced Sensor/Agent Technology
  - Real-Time Intelligent Data Acquisition
  - Real-Time Aiding and Decision Support
  - Intelligent Alerts and Client Messaging

Performance Assessment, Debriefing and Support (PADS)

- Behavioral Modeling Suite
  - Individual
  - Team
  - Aggregate Team
- Visualization Technology
  - Training
    - Post Scenario Review
  - Adaptive Decision Support
    - Displays
    - Agents

Measurement Hierarchies and Taxonomic Classification

- Model Origin
- Judgment/Decision Competency Standards
- Principle Theoretical Concepts
- Intended Use of Research Data

Competency Definitions

- Standards of Performance
  - Rationality
  - Empirical Accuracy

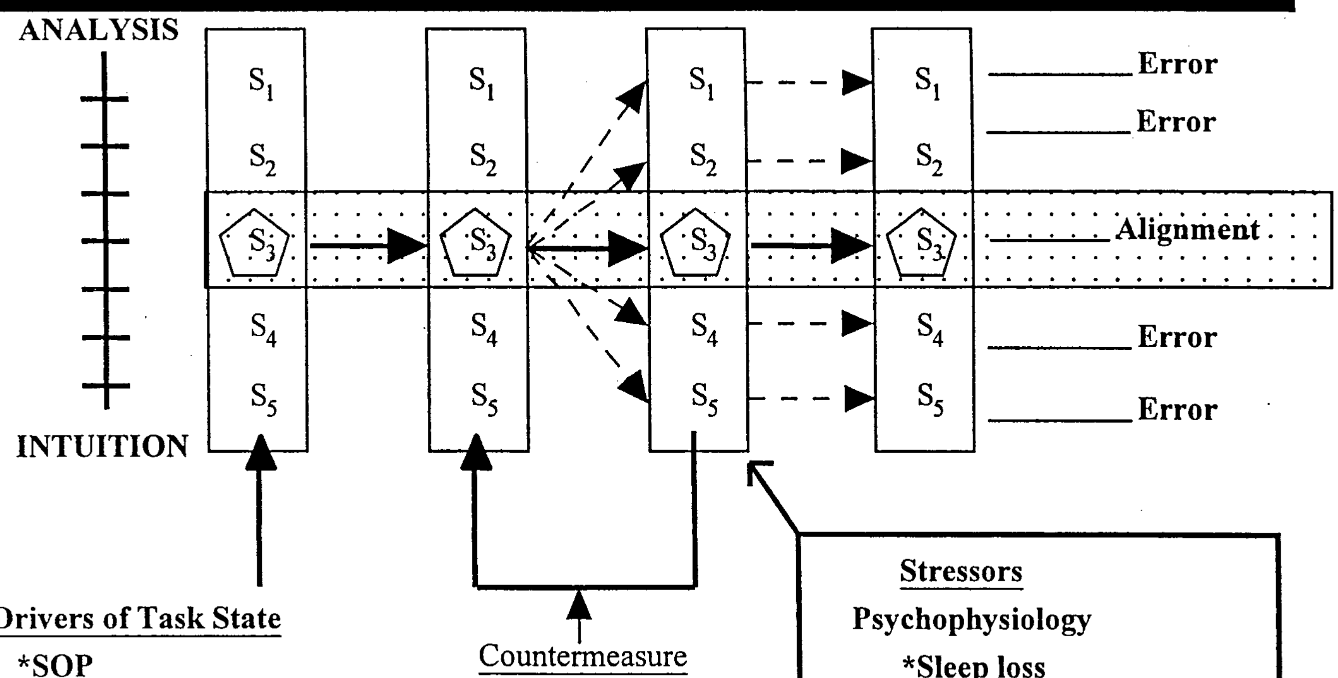
Competency Framework

- Coherence
  - Logical, Mathematical or Statistical Rules
- Correspondence
  - Accuracy

Experimental Application

- Cognitive Readiness
  - State Dependent Cognition

DYNAMIC ALIGNMENT OF COGNITIVE SYSTEM [DACS]



Drivers of Task State

- *SOP
- *Planning
- *Intelligence
- *Orders/Rules of Engagement
- *Resources/Assets
- *Terrain/Air Space

Stressors

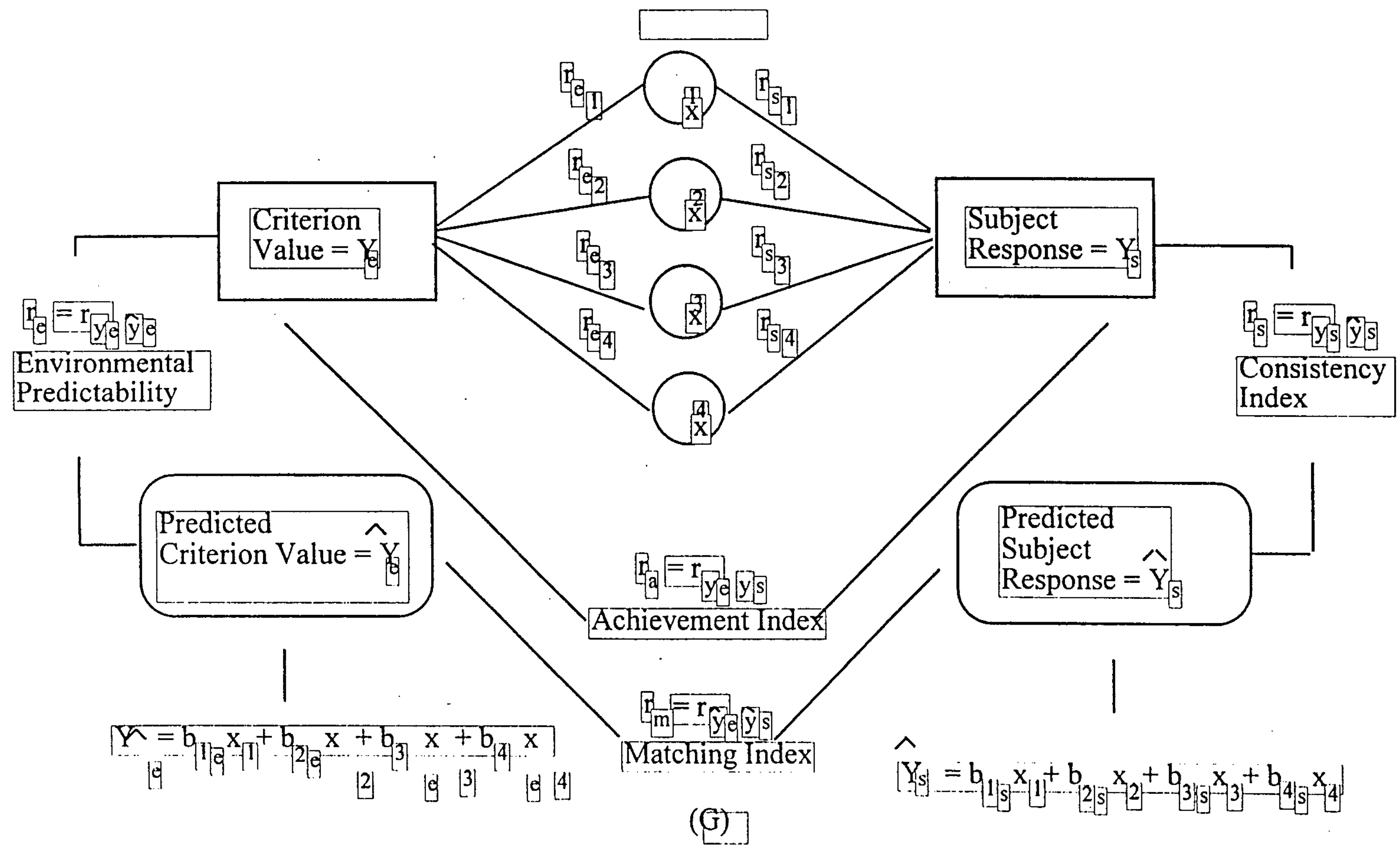
Psychophysiology

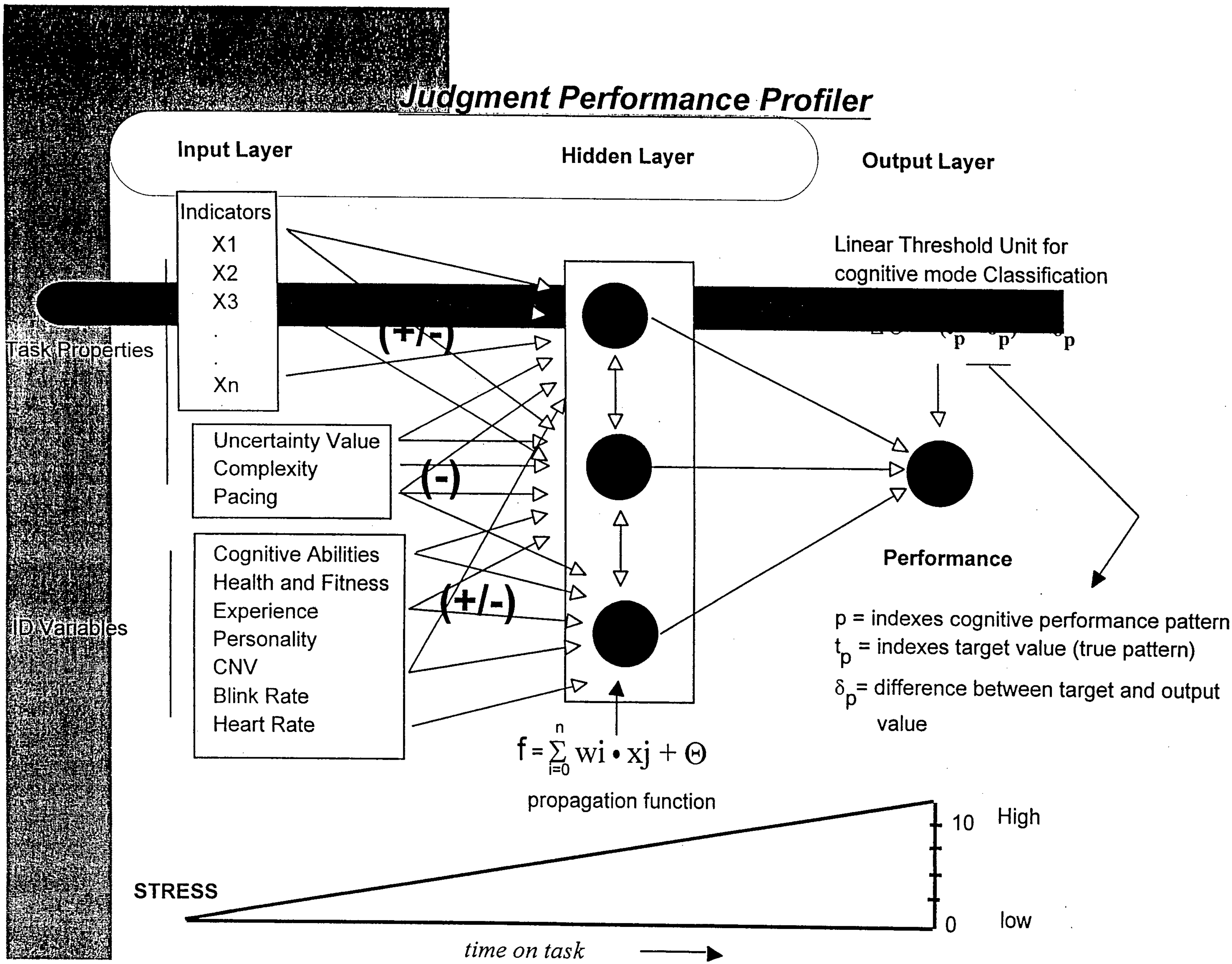
- *Sleep loss
- *Fatigue
- *Effects of Combat

ID Variables

- *Training Level
- *Cognitive Style

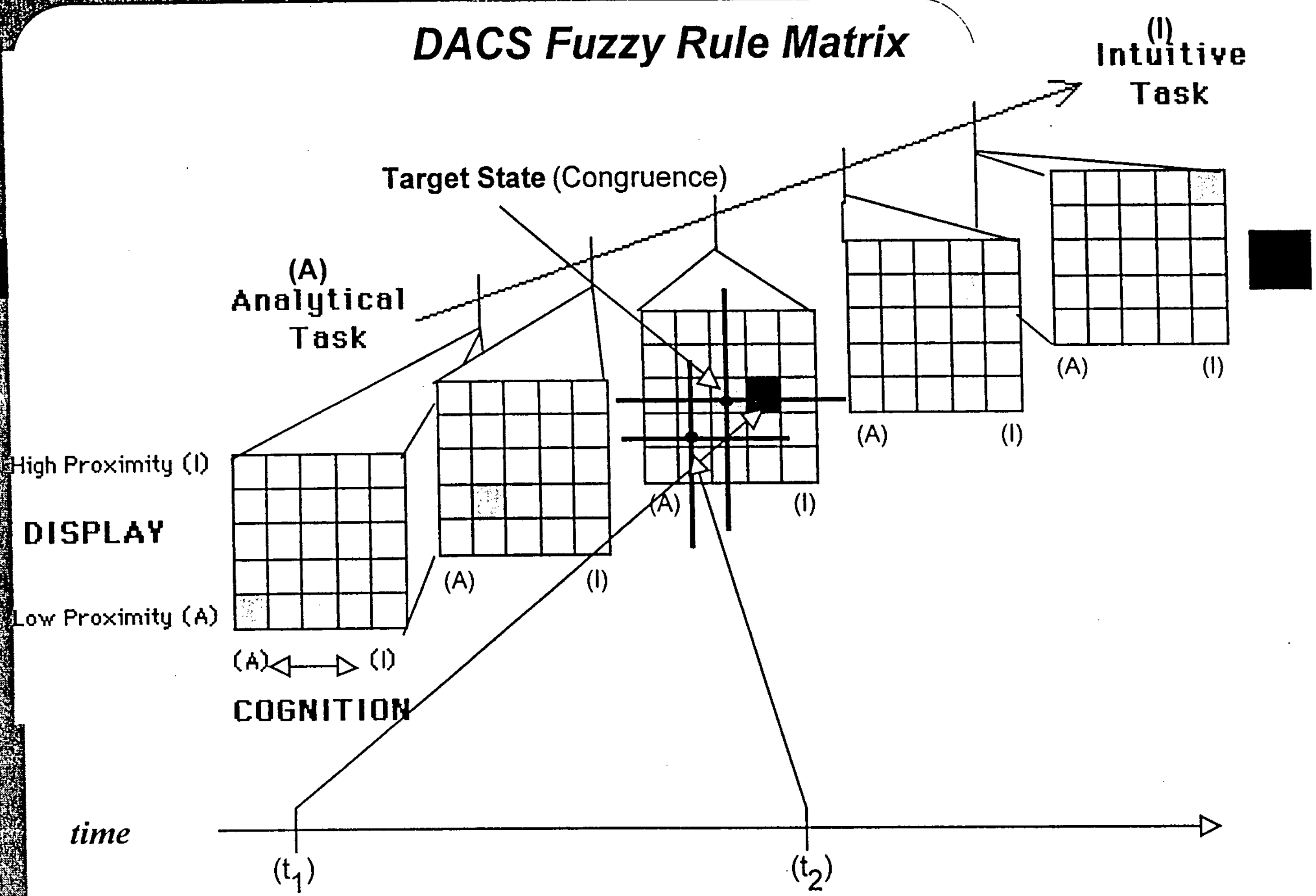
TASK INFORMATION ARRAY





Judgment Performance Profiler
Input Layer
Hidden Layer
Output Layer
Indicators
X1
X2
X3
.
.
Xn
Task Properties
Uncertainty Value
Complexity
Pacing
ID Variables
Cognitive Abilities
Health and Fitness
Experience
Personality
CNV
Blink Rate
Heart Rate
(+/-)
(-)
(+/-)
Linear Threshold Unit for
cognitive mode Classification
Performance
p = indexes cognitive performance pattern
t_p = indexes target value (true pattern)
δ_p = difference between target and output value
$f = \sum_{i=0}^{n} wi \bullet xj + \Theta$
propagation function
STRESS
10
High
0
low
time on task

DACS Fuzzy Rule Matrix

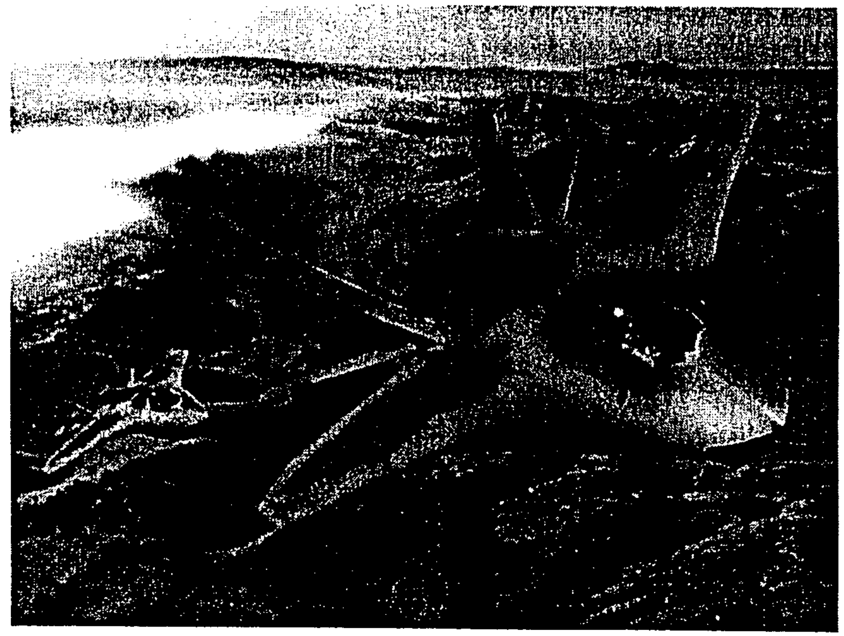


Fatigued induced
Positive_small deviation toward
Intuitive pole detected

Negative_small display
countermeasure toward
analytical pole applied

Advanced Kit Modules for Interactive Natural Environments

- Training and Feedback
  - Virtual Reality Systems
- Decision Support
  - 2D and Virtual Display
  - Agent Technology
  - Sensing Algorithms



Advanced Visualization

- Multi-Cast VR
  - Emersive Interactive Playback
  - Behavior Stamped Time-Lines
  - Client Controlled Sequencing
- After-Action Reviews
  - Display Technology

Project Time-Line (Fiscal Year)

1998 1999 2000 2001/2

Concept/Technology Piloting

Server/Client 3-Tier Architecture

Scenario/Model R&D-Data Collection

Agent/Visualization Technology

Module Integration Testing

Integrated Environmental

(Weather etc.)

Multi-Platform

SynTEAM Technology

AHRP Lab
University of Georgia
December 2000

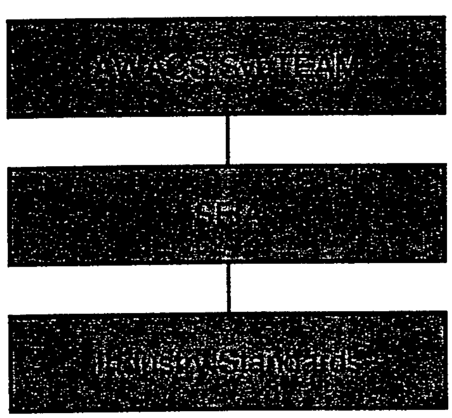
SynTEAM Design Goals

- Efficiency
  - Runs on minimal client machines
- Power
  - Easy addition of measurement algorithms
  - Hooks for high performance server
- Flexibility
  - Wide array of possible scenario kits
  - Highly configurable simulation parameters
  - Wide array of possible simulation domains

Outline

- Overall architecture
- Industry standard foundations incorporating evolving technologies
- SynTEAM Federated Internet Architecture (SFIA): Generalized distributed simulation framework
- AWACS implementation

Overall SynTEAM Architecture



Domain Information & Entity Behavior

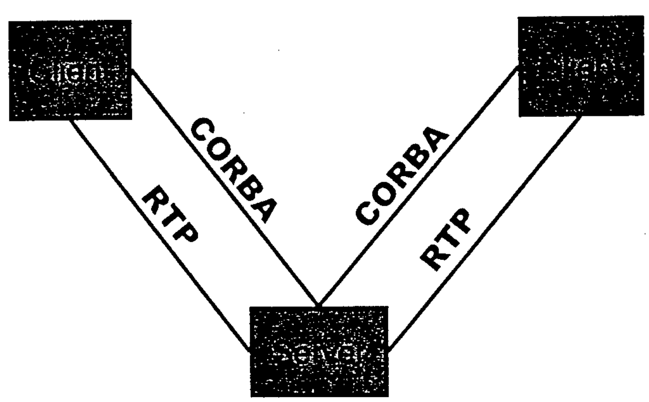
Distributed Simulation & Measurement

Java, CORBA, RTP, JMF

Industry Standard Foundations

- Java
  - Computer language, like C++, Pascal, or BASIC
  - "Write once, run anywhere"
  - Realistically, much shorter development cycles
  - Windows 9x & NT, Macintosh, *NIX (Linux, AIX, Solaris, etc.), legacy machines
  - Drawback: Speed (SFIA accommodates this)

Industry Standard Foundations



Industry Standards: CORBA

- Distributed computing protocol
  - Defines how server & clients communicate
- Uses in SynTEAM
  - Joining & starting simulations
  - Battlespace updates
  - Transmitting participants' commands
  - Text communication

CORBA Benefits

- Shorter, cheaper development cycles
- Not language-dependent
  - Can change server code without changing clients
  - Easy to replace server code with high performance language for complex measurement
  - Opens the way for SFIA & object databases
- SynTEAM's modular design allows easy protocol changes

Industry Standards: RTP

- Real-time Transport Protocol
- Used for audio & video conferencing
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    - Java standard
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    - Works great
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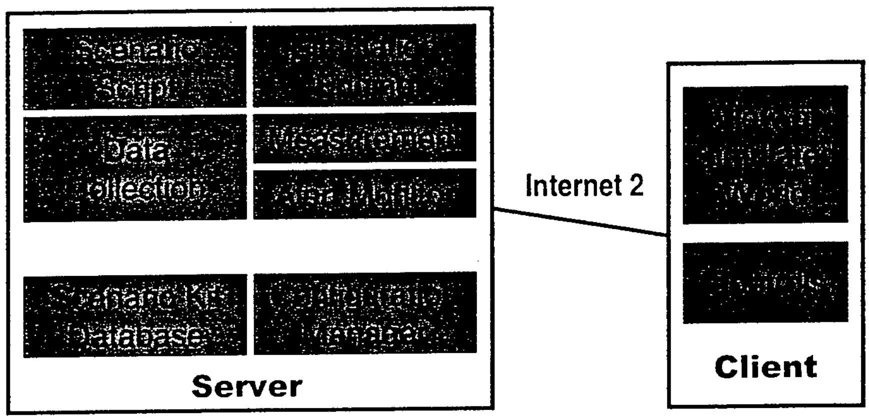
SFIA: General SynTEAM Architecture

- Not specific to AWACS
- Communication standards
  - Participants, entities, intelligent agents
- Distributed simulation logic
- Data collection
- Allows extension to other domains
  - UAV, complete force structure, civilian aerospace, business

SFIA:
General SynTEAM Architecture



SFIA:
General SynTEAM Features

- Simulation Engine
  - Maintains simulated world (battlespace)
  - Continually updates entities (planes, SAMs, etc.)
  - Configurable realism: Realism vs. performance
- Entity Specification
  - Defines how to create new entities
  - Supports addition of features to support research
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SFIA Data Collection

- Numeric and verbal formats
  - For analysis or "eyeballing"
- Translation of numeric to verbal format
- Saves a legend for numeric format
- Loads directly into Excel, SPSS, SAS, etc.

What is Recorded

- Participants' commands to...
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  - GUI display (zoom, declutter)
- All command styles
  - Keyboard, menu bar, context menu, buttons
- Automation
  - Scripted events
  - Entity-generated commands (shot down, left world)

What is Recorded

- All data time stamped
  - To 1ms or resolution of computer
- Error log
  - Accelerates bug detection & removal

SFIA Audio Conferencing

- One "Net 4" channel
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- Save separate or merged audio streams
  - Server performance vs. research need
- Configurable bandwidth / noise levels
- Hooks to add automated messages & alerts
- Current use of NetMeeting for prototyping only

SFIA Scripting Facility

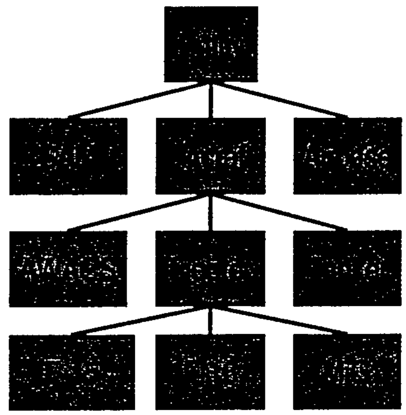
- Defines initial scenario kit setup
- Controls events in simulated world
  - Popups, scrambles, flight paths
- Hooks to add “branching” scripts in future
  - Conditional branching to predetermined sets of events

SFIA Scripting Facility

- Further configuration available at runtime
  - Realism vs. performance
  - Time compression
  - Number of participants
- Numerically coded text files
- Migration to GUI scripting tool

AWACS-Specific SynTEAM

- Entities organized in hierarchical inheritance tree
- Quick and easy to alter entities
- Easy to add new entities
- Paves the way to object databases in SFIA



AWACS-Specific Actions

- Target
- Orbit
- Pursue
- Refuel
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- Change label
- Display label
- Show / hide grid lines
- View plane stats
- Set reference point
- Joker & Bingo Calls

SynTEAM Technology

- Power
  - Easy addition of measurement algorithms
  - Hooks for high performance server
- Flexibility
  - Wide array of possible scenario kits
  - Highly configurable simulation parameters
  - Non-AWACS implementations
- Efficiency
  - Runs on minimal client machines

December 15, 2000

From AHARP (Advanced Human Research Project)

Re: Conference meeting with Computer Science

OVERVIEW

SynTEAM Federated Internet Architecture (SFIA)

SFIA is an Internet architecture framework that will support federated multi-operator distributed simulation exercises, as well as corresponding application development. The focus of this effort is to create a federated internet application system that will integrate existing and future simulators in an effort to create a scaled joint battlespace research and training program. The immediate goals of the distributed internet architecture effort is to delineate the components, protocols, and program language infrastructure that will produce a system of platform independent tools that can serve all phases of distributed internet simulation, from exercise planning and development, to execution, evaluation, and feedback. SFIA will leverage the advanced internet-II strategic alliance program, which has been designed to facilitate access to current and future highly integrated, digital communications services for education and research. Internet-II connectivity will provide reliable communications system with the ability to integrate high performance voice, data and video services in a competitive multi-vendor environment at reasonable cost and with a quality of service standard.

Three components of the SFIA

1. Simulation Authoring System- (SAS)
2. Integrative Simulation Management Engine (ISME)
3. Performance Assessment and Debriefing System (PADS)

1. Simulation Authoring System- (SAS)

SAS will be a graphic user interface tool-set that will allow rapid scripting of multi-operator exercises.

SAS will be composed of two basic modules:

Object database that will provide the battlespace entities, as well as define their properties and features.

Scripting program that will support scenario planning and development, scenario visualization, and battlespace configuration.

2. Integrated Simulation Management Engine (ISME)

ISME will provide the utilities for real-time monitoring of scenario execution, messaging, data collection and archiving, as well as other technical components of SFIA.

ISME will rely on run-time infrastructure using High Level Corba Architecture, which will provide wide-band, high-speed federated control over scenario actions. The run-time module will control multi-cast team tasks, provide capabilities to query and analyze network nodes, and furnish alerts on networking malfunctions.

3. Performance Assessment and Debriefing System (PADS)

PADS will be composed of real-time modeling of scenario performance data. In addition, it will offer the tools for offline data analysis. PADS will leverage cutting edge data visualization techniques including integral display technology and immersive 3-D protocols.

1 ▭ **SynTEAM Technology**

AHRP Lab

University of Georgia

December 2000

2 ▭ **SynTEAM Design Goals**

- Efficiency
  - Runs on minimal client machines
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3 ▭ **Outline**

- Overall architecture
- Industry standard foundations incorporating evolving technologies
- SynTEAM Federated Internet Architecture (SFIA): Generalized distributed simulation framework
- AWACS implementation

4 ▭ **Overall SynTEAM Architecture**

5 ▭ **Industry Standard Foundations**

- Java
  - Computer language, like C++, Pascal, or BASIC
  - "Write once, run anywhere"
  - Realistically, much shorter development cycles
  - Windows 9x & NT, Macintosh, *NIX (Linux, AIX, Solaris, etc.), legacy machines
  - Drawback: Speed (SFIA accommodates this)

6 ▭ **Industry Standard Foundations**

7 ▭ **Industry Standards: CORBA**

- Distributed computing protocol
  - Defines how server & clients communicate
- Uses in SynTEAM
  - Joining & starting simulations
  - Battlespace updates
  - Transmitting participants' commands
  - Text communication

8 ▭ **CORBA Benefits**

- Shorter, cheaper development cycles
- Not language-dependent
  - Can change server code without changing clients
  - Easy to replace server code with high performance language for complex measurement
  - Opens the way for SFIA & object databases
- SynTEAM's modular design allows easy protocol changes

9 ▭ **Industry Standards: RTP**

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